Who Gets Left Behind in the Push for Smart Cities? Insights From Marginalized Communities

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Abstract. Smart cities take advantage of advances in ubiquitous computing and big data analytics to build and deploy technologies that increase efficiency and sustainability. However, benefits derived from smart cities are not equally distributed. In this paper, we consider how smart city initiatives can better serve and engage marginalized communities through a focus on the city of Baltimore, MD. Through focus groups with 43 Black Baltimore residents living in low-income neighborhoods, we identify key barriers they perceive to being more engaged in and trusting of smart city initiatives, as well as important disconnects between residents' needs and the city's solutions. Based on these findings, we make the case for cities to more deeply engage these communities in smart city initiatives, as many technologies are not designed with their unique needs in mind, and they are the most likely to experience harms from surveillance technologies that collect large quantities of data and build predictive models used by cities.

Keywords: Smart Cities, Privacy, Marginalized Communities, Digital Divide, Digital Literacy.

1 Introduction

Over the last decade, cities around the world have implemented policies and technologies to make themselves "smarter." This has led to the coining of the term "smart cities," in-depth analyses by scholars, and corporate campaigns designed to profit from this increasing reliance on data-driven decision-making based on data collected from residents and their environment. Smart city technologies span nearly all aspects of cities, from energy and transportation to public safety and infrastructure.

Rob Kitchin [26] notes that definitions of smart cities tend to focus on two things: the technology itself and the development of a "knowledge economy." First, smart cities are only possible thanks to the tremendous rise in ubiquitous computing, leading to what Greenfield [16] refers to as "everyware"—an environment where computing is no longer limited to a small set of devices but instead can be found nearly everywhere and in everything, and is "used to monitor, manage and regulate city flows and processes, often in real-time" (p. 2). More broadly, smart cities reflect an increased focus on the knowledge economy being essential to growth. In other words, by collecting more data from cities and people moving through them, officials will be

better positioned to innovate. Kitchin [26] further notes that what makes a city "smart" is how technology is used in decision- and policy-making to leverage growth.

Given the vast amount of data collection occurring in smart cities, we must consider disparate impacts of data collection and surveillance on marginalized populations. Most US cities have higher concentrations of impoverished and of minority populations [15]. These groups face disproportionate amounts of government surveillance. Madden and colleagues [30] describe this as a "matrix of vulnerabilities that low-income people face as a result of the collection and aggregation of big data and the application of predictive analytics" (p. 53). They note that the increasing reliance on mobile and internet technologies will likely increase privacy harms, especially given that many new technologies exhibit biases against these populations [36, 42].

In this paper, we consider one aspect of smart city initiatives: public transportation. Buses, light rails, and subways provide critical infrastructure to city residents, and they are often the only form of transportation available to low-income residents. Given the shift toward decentralization of employment in cities [14], many of the poorest residents live in central parts of the city but travel to outer parts for work. Research shows that lower-income residents endure more complex and longer trips on public transit, requiring multiple modes and/or transfers, when compared to higher-income residents [37]. This is especially important given the link between geographic and economic mobility: those who can move around more easily are more likely to improve their economic standing [23].

We focus on the city of Baltimore, Maryland, the state's largest city (population: 570,000). More than 60% of the population is Black, and more than 20% of the city's residents fall below the poverty line [43]. Baltimore has also been an early adopter in data analytics at scale; in 1999, the city launched CitiStat, a program that required government agencies to regularly generate and share performance data with the mayor's office [20]. By 2018, Baltimore was investing in various smart city initiatives, from more energy-efficient lighting to smart trash bins and ShotSpotter devices. However, public transportation has faced continuing challenges that have not been helped by the city's increasing reliance on technology, and the city's transit system is one of the most class- and race-segregated in the US [3].

We build on prior work considering how technology can support the needs of low-income residents of Baltimore City [28, 29]. They found that Black residents were frustrated with the quality of public transit and felt it limited access to work and educational opportunities. Some of the most equity-disadvantaged neighborhoods in Baltimore have the highest percentage of people using public transit and longest commute times in the country [22]. That said, it's unclear whether these residents' voices and experiences are considered as part of decision-making about public transit, nor whether privacy considerations play any role in their thoughts on smart technology.

Lung-Amam and colleagues [28] noted that Baltimore should work closely with residents in addressing these challenges, so we set out to gain a deeper understanding of residents' needs, as well as barriers that may prevent them from being more engaged in smart city initiatives. We ask two key research questions:

> **RQ1:** What barriers do Baltimore residents perceive to their engagement in the development and expansion of smart city initiatives?

RQ2: What do Baltimore residents want or need to promote the development and expansion of smart city initiatives?

Findings from focus groups with 43 Black, low-income Baltimore residents highlight two key barriers to feeling more engaged in smart city initiatives: low digital literacy and a lack of trust. In terms of needs, residents want solutions that are less about the technology and focus more on addressing challenges they face in their day-to-day lives. Beyond that, residents want greater transparency about data collection practices and more direct engagement with residents to identify and respond to their most pressing needs. Based on these findings, we argue that cities need to do more to involve residents—and particularly residents like those we spoke to—in the development and deployment of smart city initiatives. By including residents more deeply in the process and providing them with greater transparency about the data collected through smart technologies, cities may be able to build trust with their residents and ensure new initiatives do not create additional challenges for marginalized communities.

2 Background

Technology is at the core of most definitions of smart cities [17, 21, 41]. For example, Townsend [41] defines smart cities as "places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems" (p. 15). These technologies make a city "smart" by collecting real-time data from sensors around the city. That data is then analyzed and visualized for city officials to aid decision-making.

Smart city technologies span government services, urban infrastructure, energy, and the environment. Of particular interest for this paper is how smart cities are reflected in public transportation. New technologies enable real-time data processing to make transportation smarter (e.g., real-time location information for tracking and monitoring public transportation services [34]). For example, Baltimore introduced a smartphone application [1] in 2023 to expand their assisted mobility services for smartphone users.

2.1 Privacy Concerns in Smart Cities

Most smart city technologies are integrated into city infrastructures to improve efficiency and quality of services [7]. These technologies collect, analyze, and distribute citizens' data [25, 26], and their use has privacy implications. Helbing et al. [19] argue that mass surveillance is why privacy is so often violated in smart cities. Data used for services can also be used for surveillance purposes [45], with potential harms arising when using data to draw inferences about residents as well as issues with anonymization, reidentification, and ineffective/absent notice and consent [24].

For residents to fully accept smart cities, 'respect of privacy' is a crucial value [32], as reflected in the need for transparency between public and private sectors involved in smart city development. In fact, when people's privacy concerns are not addressed,

[1] https://www.mta.maryland.gov/mobility-all-access

smart city projects fail, as seen in the case of Sidewalk Toronto, a project that faced backlash from privacy advocates because of its lack of transparency and accountability around the collection and use of data [12, 31].

However, limited research has investigated residents' privacy concerns regarding smart cities. When people participate in smart city projects, information security is a concern, especially regarding data anonymity and access [8]. On the other hand, Belanche-Gracia et al. [1] found that smartcard users in Spain perceived smartcard data to be limited and trusted local authorities in managing the information. Calculation of tradeoffs also impacts acceptance of surveillance technologies; van Heek et al. [18] found that people are more likely to trade their privacy for safety in places they think are unsafe. To improve residents' confidence in using smart cities, Chatterjee et al. [6] emphasized the role of IT authorities to address privacy and security issues.

2.2 Increased Risk of Harms for Marginalized Communities

Smart city technologies can negatively impact marginalized communities' privacy. Research has highlighted that lower-income/education individuals have less awareness of privacy risks and are more vulnerable to data breaches and security-related harms [30]. Vitak et al. [44] found that economically disadvantaged internet users face barriers to understanding privacy risks, practicing privacy-protective behaviors, and trusting information intermediaries due to lower digital literacy. Likewise, marginalized communities rely on mobile phones over computers, which exacerbates vulnerabilities and risk exposure [29].

Given that smart cities frequently utilize crowdsourced data from citizens' smartphones to reduce infrastructure costs [8], the privacy and security implications—especially for marginalized communities—are concerning. Emami-Naeini et al. [11] argue that marginalized populations' perceptions of benefits and harms of smart cities might be more pronounced than—and not easily generalizable to—the general population because concerns are linked to socioeconomic status; lower-income respondents were more concerned about the ethical implications of certain scenarios (e.g., deploying gunshot spotters) because scenarios like gun violence were more relevant to them. Older adults also face increased privacy risks due to their lack of access to physical, social, and digital resources; Sourbati and Behrendt [40] argue this hinders inclusiveness in smart cities and may increase social inequality.

Lung-Amam et al. [29] note that few studies have considered the privacy implications for marginalized populations in smart cities. They investigated how smart city technology impacted low-income neighborhoods and found public transportation as one of residents' main interests. Building on their work, Frias-Martinez et al. [13] investigated how privacy might prevent low-income residents from participating in a city's mobile-based data collection efforts. They note that current metrics measuring mobility experience leave out transit-dependent, equity-challenged communities' experiences because they ignore the multi-modal/legged trips that lower-income residents must face.

3 Method

This study directly builds on Lung-Amam et al.'s [29] work and complements previous studies regarding marginalized populations in smart cities [11, 40] by investigating the lived experiences of low-income residents of color. This paper is part of a larger NSF-funded project developing privacy-preserving public transit tools to serve low-income residents in Baltimore, MD, a medium-sized city on the US' east coast. Baltimore launched a major smart city initiative in 2018 [9]. Among its goals was addressing chronic problems with public transportation [10]. Baltimore has one of the worst public transportation systems in the US, with some of the longest commute times for residents using public transportation [22].

3.1 Procedure

The project team includes several Baltimore-based partner organizations, and we worked closely with the Housing Authority of Baltimore City (HABC)[2] to identify low-income, majority Black neighborhoods where residents relied heavily on public transit and to help coordinate focus group sessions in these neighborhoods. Data collection was initially planned for late 2020; however, pandemic restrictions delayed data collection until summer 2021. We also planned to use a mix of interviews and focus groups; however, after conducting two pilot phone interviews, we determined that in-person, group-based discussions would better suit our research goals.

Coordinating with HABC staff working in these neighborhoods, we began recruiting residents in June 2021 for 90-minute focus group sessions to be held in one of three HABC community spaces. Over the next 10 months, we held eight sessions with 43 residents (63% female; age range: 20s–70s) in the three locations through the city (see Table 1). While we purposefully did not collect detailed demographic information from participants, we did confirm there (1) were a resident of the neighborhood; (2) used public transportation (bus, light rail, subway, and/or mobility services) at least monthly; and (3) owned a smartphone. Each session included 4-8 participants as well as 1-3 team members. All sessions were audio recorded. Participants received a US$50 gift card to Amazon or Wal-Mart.

Focus groups were organized into four sections. First, we asked about participants' general experiences with public transportation. This was meant to build rapport with and between participants, and to get participants comfortable with the focus group format. Second, we discussed perceptions of smart city technology. To facilitate this, participants reviewed and discussed a handout with descriptions of common smart city technologies (e.g., trash cans, gunshot detectors) and mobile apps (e.g., contact tracing, public transit). Third, we asked participants to discuss their experiences with and perceptions toward public transit apps, as well as any data privacy concerns they had using these apps or smartphones more generally. We concluded by asking them to share

[2] HABC provides numerous services to low-income residents, including management of public housing programs. As of 2023, they managed 7000 public housing units at 21 sites across Baltimore.

their needs and wants for public transit apps. The full protocol (including handouts) is in the supplemental materials.

Table 1: Focus group locations and participants.

Location / Session ID	Date	# Partici-pants	Participant IDs[1]	Community Description
A1	July 2021	6	P21-P26	Location A is in West Baltimore and has 200+ units for older adults. There is one bus stop nearby; to get to the closest grocery store takes 50 minutes by bus.
B1	Aug 2021	4	P3-P6	Location B is in West Baltimore and has 200+ units. It primarily serves older adults and people with disabilities. Like Location A, it has a bus stop nearby but is not close to major grocery stores; there are accessible "corner stores" but prices are much higher. Many residents use Mobility or cab services.
B2	Aug 2021	5	P7-P11	
B3	Aug 2021	5	P12-P16	
C1	Nov 2021	4	P17-P20	Location C is in Central Baltimore and has 1200+ units, primarily serving families. The community includes a daycare and aquatic center. There is one shopping center close by with a limited number of stores. Residents have no access to grocery stores in the area. Multiple forms of public transportation (bus stops and light rail) are within walking distance.
C2	April 2022	5	P27-P31	
C3	April 2022	8	P32-P39	
C4	April 2022	6	P40-P45	

[1] P1 and P2 were part of the pilot data collection; their data is not included in this analysis.

3.2 Data Analysis

When recording sessions, we used multiple recorders to capture everyone's comments. However, audio quality was relatively poor for several reasons. First, while we purposefully chose to collect data in the building/neighborhood where participants lived, these spaces were not optimal for data collection. At Location C, for example, sessions took place in a large space with high ceilings, causing some sound distortion. At Location B, sessions were conducted in a room adjacent to building construction, which added noise. In most sessions, participants were spread out and/or masked because of pandemic restrictions or concerns. We carefully reviewed each transcript,

audio files, and researcher notes to fill in places where professional transcribers were unsure, noting places where audio quality was too poor to transcribe.

Transcripts were uploaded to Atlas.ti for qualitative analysis. Following Miles et al. [33], we developed an initial codebook based on the project's overarching research questions, the focus group protocol, and notes from the first four sessions. We continued collecting data for several months, determining saturation had been reached [39] after the April 2022 sessions. We revisited the codebook and discussed additional updates and clarifications to each code, then each transcript was read and coded by both authors. Following this, we exported excerpts and completed a thematic analysis [2, 38] of three codes: public transportation dislikes; data privacy concerns and management; and digital/tech literacy. For this step, the first author read through all excerpts for a given code multiple times to identify patterns across participants and sessions, then wrote detailed memos summarizing themes and providing examples from the data.

4 Findings

4.1 RQ1: Barriers to Engagement in Smart City Initiatives

RQ1 explored residents' attitudes toward smart city initiatives and barriers to being more engaged with the city's smart city initiatives. Below, we highlight two interconnected themes that emerged: low digital literacy and trust.

Barrier #1: Low Digital Literacy and Limited Knowledge of Smart Technologies. Most participants reported having limited knowledge of smart technologies and low digital literacy. Many described challenges using their phone effectively to accomplish tasks. For example, P5 described constant frustration with her phone, saying, "I struggle with the different apps. I don't do nothing but make phone calls." Similarly, P4 described feeling uncomfortable using her smartphone: "I just had the feeling that I'm going to mess something up. If I get to pressing buttons and stuff like that, it's not going to register correctly."

While a few younger participants self-described themselves as more tech-savvy, many turned to family and neighbors for help using their smartphones. P3, who affectionately referred to her nine grandchildren as "computer geeks," regularly got technical help from them: "When it comes down to something I really don't understand, one of them will take time to explain it to me. And they know it's going to take awhile… but they set it up, and they show me what to do after."

Struggles and successes with smartphone apps were often discussed as they related to transit apps, including Google Maps, ride-share apps, and public transportation apps like Transit, which provide real-time information about bus schedules. P31 and P41 relied heavily on grandchildren to help map out trips or find when the next bus was coming. When asked about reasons for *not* using public transportation apps, P41 replied, "I ask my children or grandchildren. I'll get frustrated by the time I look at it and find it and go through it, and I'm like, 'I do not understand. Will y'all tell me?'"

Given this low technical proficiency, it is unsurprising that participants' knowledge of smart city technology was limited. Most had never heard the term, and while some recognized examples because they encountered them in their everyday life, they

frequently misunderstood how technologies worked. P14 thought that the Array of Things would expose him to radiation: "All that radiation, it's contaminating the neighborhood and yourself and the environment." P17 "found it upsetting" that the contact tracing application "made" the health department call her to get vaccinated, and eventually "took it off [her smartphone]."

Barrier #2: Low Trust in Technology—and City Officials. As described above, many residents misunderstood aspects of how smart cities and smartphone applications worked, and sometimes that misunderstanding led them to distrust the effectiveness or utility of these technologies—or city officials. P19 strongly believed gunshot detectors were "a decoy to deter criminals," noting that "the city once admitted…that certain cameras in a certain community wasn't working." This made him skeptical of "how many times [workers] go around maintaining these cameras." P19 also expressed concerns about the city monitoring residents, saying "I want to feel free….I don't want to be monitored all the time, where I go and what I do." P17 replied, "Big Brother is always watching. Ain't nothing we can do."

A similar skepticism was expressed regarding smart trash bins deployed throughout the city. Participants were surprised that the trash bins were "smart," with several noting that the technology didn't work properly. For example, P27 mentioned, "Trust me, I don't know if the sensor works, but it's full to capacity. I don't care what day you go past there, trash is hanging all over." Likewise, P17 mentioned seeing gunshot detectors attached to cameras but wasn't sure they were working because "I know they come periodically and change the cameras, but I never see them do anything with the ShotSpotter." P19 chimed in, asking: "How many of them [ShotSpotter] are fake? Because I'm sure some of them are fake."

Given data collection occurred during 2021-2022, we asked about contact tracing apps, which typically use Bluetooth and self-reports to alert people when they have been near someone who recently tested COVID-19 positive. There was definitely confusion about how they worked—we noted above that P17 thought she was getting calls from the city's health department because she downloaded the app. In fact, several participants expressed skepticism or unease with contact tracing apps because they erroneously believed they allowed government or health officials to track them. Research suggests trust in government decreased during the pandemic [40]; comments by our participants suggested there was either a lack of communication or miscommunication about contact tracing apps, leading to distrust or skepticism.

Participants also lacked trust in technology companies. During a conversation about how long apps should retain user data, P14 mentioned he wanted data deleted from his phone after "30-60 days, it should be gone. Because then I don't feel as though you may be infringing on my privacy." P13 replied, "But after whatever it goes on, and then they said it never goes away, it's always on there," adding, "None of us are probably technically equipped even fully on our own phones. Much less trying to dig into the people that can go and hack your stuff."

A heated discussion during Session C3 highlighted participants' low regarding data collection. When asked if they had any concerns about transit data being collected and shared with the local transit authority, P33 said, "If they want something off your phone, they can get anything off your phone." P38 replied, "All they need to know is trips I

take with them. They don't need anything else…. They don't know me personally, why they need my history?" Others in this session strongly agreed with this sentiment. P36 then joined the conversation, suggesting that apps could access all phone data: "All the data is just there. They say, we'll get all the data from Transit, but you still got the rest of the data on your phone, got all the calls that she had within that day, that she caught the bus or something like that."

4.2 RQ2: Residents Highlight Key Needs for Smart City Engagement

In addressing RQ2, we found a mismatch between what residents needed and what the city offered them. We focus on two core themes: smart city initiatives that don't address core problems faced by residents, and a lack of community engagement in developing and communicating about changes to existing programs and services.

Need #1: Solutions That Address Residents' Issues Simply. In our discussions of smart city initiatives broadly—and transit apps specifically—residents were skeptical that technical solutions would solve city problems. Several participants primarily used MobilityLink, a specialized transit service for those with mobility limitations. To use this service, residents could use a website or, more recently, a smartphone app. However, given that many participants previously mentioned they either don't use transit apps or use them in limited ways, it was unsurprising that they said they preferred making reservations over the phone. P29 expressed his frustration with calling MobilityLink as "donuts," meaning that you would go around in circles on the phone: "[MobilityLink] sticks you to somebody else. Then they stick you to somebody else. It works like that." P41 also described difficulties making reservations over the phone, saying that "whoever's doing the scheduling does not know what they're doing." Participants complained there was no way to communicate with drivers or get information when a driver was running late, and this lack of information could make the process of getting transportation very tedious.

It was also clear to participants that some of the city's "smart" solutions were not all that smart. As noted above, discussions related to the smart trash bins highlighted that adding chips to them didn't seem to reduce the amount of trash on the ground, and participants were skeptical that devices like ShotSpotter were real. If such straightforward forms of smart technology (e.g., adding sensors to alert the city when the bin is full) don't work, why should residents trust that more complex technological solutions will? From our participants' perspective, their needs were much more basic and weren't being addressed through more complicated, technology-driven solutions.

Need #2: More Transparency From the City, More Direct Engagement With Residents. Participants repeatedly shared examples of recent changes to the city's bus system that made it more confusing and inconvenient. This included changes to routes, changes in the scheduling—including reducing the frequency of weekend buses—changes that required more transfers, and changes to how bus routes were labeled. Furthermore, participants said it was unclear *why* these changes were made, and they suspected that whoever made the changes did not use public transportation themselves. P17 said, "Whoever changed the MTA schedule and changed the buses from numbers to colors, he don't catch the bus. That's my whole problem. …when you going to

implement something, if you don't use it, I don't need your help." Similarly, P38 mentioned hearing the administrator brought in to update the bus system wasn't from Baltimore and P33 replied, "It's probably somebody that never even caught a bus. They probably don't even touch buses." So, when we asked participants what they wanted to make their public transportation experience better, all they wanted was for the city to undo these changes. P31 explained, "If [city officials are] going to consider things, why don't they consider restoring the skipped stops they moved for no just cause."

If there were clear reasons for these changes, residents were unaware. Such discrepancies between city services and what residents actually need are due, in part, to a lack of community engagement in planning and implementing changes to core city services. Prior comments from participants about their misunderstandings or lack of knowledge of smart city initiatives suggest that current strategies for communicating about changes are lacking. One example of this was seen during Session C1, where participants discussed a groundbreaking at a local park. P19 was frustrated he hadn't gotten any information about the event, saying, "I want to know what's going on in my community. They should have put fliers in everybody's door saying, 'This is going to happen this day.' No one on my block got a flier or anything."

Participants also wanted more transparency regarding data collected by the city to ensure it benefited their community. P43 asked, "Can we go to the library to find out who's collecting data and what the data is being used for, and whether they are able to use it for the community that they collected the data from?" Our participants demanded direct benefits to their community because they felt their communities have been neglected; for example, P43 said, "Sometimes they take your data and sell it, and other communities more affluent than ours benefit from our data." P43 also noted problematic ways data could be used: "They use that data to say, 'well this is why we don't want to build a supermarket in this community,' 'this is why we need a gated community.'" Finally, they wanted data collection to have clear benefits like improved safety, but they didn't see that happening, with P27 noting that "the data is not keeping the city safe."

While frustrated, participants also acknowledged the importance of participating in the community meetings to help shape policy. For example, P21 said that for people "that don't have a car, they rely on public transportation. But you can't expect a bus to come on time, or … for them to put more buses on a line on Sunday if you don't go to a meeting and speak about it." Despite knowing and wanting to attend meetings, participants complained about the timing, saying meetings were held at unfavorable times and places. P17 noted that a lot of the community meetings were held far from their neighborhood. Instead, she suggested, "For every area where you have a bus situation, in all those areas they [could] have meetings."

5 Discussion

When we began collecting data for this study, we were most interested in residents' privacy concerns arising from smart city initiatives and the data collected from residents. However, it quickly became clear that data privacy was just not a priority for

most residents. Instead, they were more concerned with changes that negatively impacted their daily life, such as changes to public buses that added time and inconvenience to their day. This disconnect is concerning and highlights how the needs and wants of the most vulnerable can be overlooked in the push to advance the city economically and technologically.

The findings from this study provide a direct extension to Lung-Amam et al.'s [28, 29] work, which engaged West Baltimore residents to explore smart city technologies and considered ways to better engage the community in planning and policymaking. Lung-Amam et al. [29] found that because many residents lacked reliable computer access and relied on mobile devices to complete tasks, the city should leverage this by creating more app-based services. However, our study, which included a significant number of adults ages 50+, found that many struggled to effectively use their smartphones. This was especially clear for participants who used MobilityLink services and preferred calling to using the website or mobile app. Given the shift to virtual scheduling, it's likely there are limited resources for residents who want to reserve via phone. It's also unclear if the city conducted any research with residents who use MobilityLink before building an app to see if that solution matched the needs and skills of its primary users.

The role of trust in building out smart cities cannot be understated. One of the largest smart city initiatives globally—featuring a collaboration between Google's Sidewalk Labs and the City of Toronto—collapsed in large part because the needs and goals of key stakeholders conflicted [12]. This was highlighted when privacy expert Ann Cavoukian resigned from the project in 2018 due to data privacy concerns [5]. Lung-Aman et al. [29] trace a long history of distrust by marginalized Baltimore residents toward city officials. In our conversations, we found this lack of trust extended to both smart city technologies—especially when they didn't work in expected ways or when there was high uncertainty regarding their purpose—as well as city officials collecting data from residents.

This mistrust is especially concerning when considering the wider landscape in which smart city data collection occurs. Poor and minoritized communities have historically faced both greater surveillance and worse outcomes from surveillance [4, 30]. Prior work evaluating privacy risks faced by this population [44] found that low digital literacy and a lack of reliable computer access led many low-income families to distrust online content, companies, and the government; this distrust can lead to rejecting technologies outright or developing misconceptions about the uses of a given technology. Of course, when it comes to smart city initiatives, it is often difficult—if not impossible—to reject a technology. Those who rely on public transportation cannot opt-out of camera surveillance; those who use Google Maps or the Transit app may need to share their location to use the service. A few of our participants expressed unease with the growing use of everyware throughout the city, sometimes expressing resignation to being watched by "big brother."

Many of the barriers residents described that prevent them from greater engagement in smart city initiatives can be addressed by involving them in development and decision-making processes. This is certainly not a novel idea, but it's clear that cities are still largely ignoring the needs of their most marginalized residents. Lung-

Amam and colleagues [29] make a compelling argument for institutionalizing engagement mechanisms to involve local communities in smart city initiatives, noting, "For smart city investments to work *for* communities, rather than just *in* them, smart city planning must help to build and repair community trust, leverage existing neighborhood assets, facilitate residents' access and choice, and recognize the diversity within and between disadvantaged neighborhoods" (p. 107, emphasis in original). Our research strongly supports this assertion and highlights places where current policies do not align with residents' needs.

Beyond seeking direct input from residents and involving them in the development process, our findings support the call for cities to be more open and transparent regarding smart city data collection and use. Data access initiatives can take many forms, but it's clear both from our data and previous studies [8, 29] that residents want access to their data and want to have a greater say in how that data is used. Such access could also reduce the likelihood of data being used in problematic ways, as residents and local organizations could review city policies, conduct data audits, and ensure data is not being used to engage in biased predictions—something that has a long history of causing harms to marginalized communities [36, 42].

6 Conclusion

The push toward smart cities may feel inevitable, but it's clear there are better and worse ways to implement technologies that collect massive amounts of data about residents. Techno-solutionism—the frequently heard refrain by those who think technology can fix any problem [35]—is especially problematic for those on the margins, whose experiences and needs differ from those with the money and knowledge to fully benefit from new technologies [11].

In this study, we extended prior work [28, 29] evaluating smart city initiatives in Baltimore, Maryland. Through focus groups with 43 low-income, Black residents, with a special focus on public transit, we explored barriers they perceive to greater engagement with smart city initiatives and the mismatch between their needs and city solutions. These findings reiterate the urgent need for greater citizen engagement—especially with those who most likely to be negatively affected by these initiatives—in needs assessment, development, and evaluation of data-driven projects. It is important to note that even though these residents had limited technical knowledge, they understood the importance of transparency regarding and access to their data.

Some of the challenges and concerns we identified may be addressed soon. In December 2023, the Baltimore City Office of Information and Technology released a five-year Digital Inclusion Strategy to reduce the digital divide and promote digital equity in the city [47]. Specific action goals (e.g., digital skills training) will help alleviate fundamental barriers our participants faced that prevented full engagement in the smart city. The strategy's plan to involve low-income and older residents of color in policy development [46] can further amplify marginalized populations' voice and highlight needs that are often neglected by current metrics for measuring quality of services.

While this study is limited to a small number of residents in one city in the US, we hope the experiences of Baltimore's residents reaffirm calls from prior researchers [27, 29] to pursue smart cities that create truly connected communities and create better futures for *all* residents.

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Supplemental File

FOCUS GROUP PROTOCOL
April 2021

Moderator: Welcome and thank you for joining us today for this focus group. [Moderator introduces themselves and any other colleagues attending]. Today we'll be talking about your experience using public transportation and your thoughts on public transit smartphone apps. The format of this session is a focus group. If you've never done one of these before, I have a set of questions I'd like to open up to discussion, but there's no formal method for answering. I encourage everyone to share their thoughts. My role is merely to facilitate the conversation; you all will be guiding it.

I'll also be recording the session today, but I want to assure you that whatever is being shared in this room today stays with us, and anything we use from this conversation today to develop resources or publications will not be connected to your real name. This session is scheduled to last 60-90 minutes. Does anyone have questions before we start?

[Open to questions] ***-- START RECORDING***

Moderator: Great. Let's start with a warm-up activity. Could we go around the room and have each person share their name and which neighborhood they live in?

[Discussion]

Moderator: First, we want to hear about your experiences with public transportation. This includes buses, the subway, paratransit, and the trains. Can you share your general thoughts on Baltimore's current public transportation offerings and positive or negative experiences you've had using it?

> **Prompts:** How do your experiences differ on the different systems (bus vs. light rail vs. subway)?
> **Prompts**: How do your experiences differ before and after the pandemic?
> **Prompts:** What are the main reasons you use public transportation (e.g., shopping, visiting family, etc.)?
> **Follow-up:** What are things that could be done to improve your travel on Baltimore transportation?

Moderator: Next, I want to talk about smart cities, which you may or may not be familiar with. Smart city technologies use sensors and cameras to collect data about residents and the environment and use this data to help city officials make planning decisions in order to improve residents' quality of life. Smart city technologies include smart garbage bins, smart energy, and smartcards for using public transit. For example, the Department of Transportation (DOT) might collect data on pedestrian traffic around the city to help them make decisions about where to add additional crosswalks, or they might use traffic light sensors to automatically ticket cars that run red lights. Other examples could be the police using gunshot detectors or other sensors to help them identify and respond to crimes more quickly. The city's sanitation department may

add sensors to trash cans to identify when they are full. Are you familiar with any of these kinds of technologies and what are your thoughts about them?

Prompts: Have you ever heard the term “smart cities” before?
Prompts: Have you ever seen/experienced any of these technologies?
Follow-ups: What do you think are the pros and cons of smart city technology?

[Discussion]

I want to dig into this idea of smart cities some more so we’re going to go through a few examples of smart technologies that may be used in Baltimore or other cities in the US. For each example, we’ll give you a description of how it works, then we have a few questions regarding the technology. We want to know your thoughts on these technologies, how comfortable you are with them, and what kind of data they collect.

[Have people look at handout while talking about them -- there are three apps on one side and three smart city sensor examples on the other]

Potential questions for each example (time permitting):

1. What are your thoughts on this technology?
2. Would you feel comfortable using this/having this used in your neighborhood? Why do you feel that way / what makes you (un)comfortable?
3. Think about the type of data this app/technology collects. Do you have any concerns? For example, do you care who gets access to this data?

[Discussion]

Moderator: Now that we’ve talked about smart city technologies and public transportation broadly, let’s focus on smart public transit. Smart public transportation collects data about how people move through the city and use this data to monitor pedestrian and car traffic, reduce congestion, and improve residents’ public transportation experience. An example of that is transit apps on your phone. Transit apps provide real-time public transportation status and recommendations based on a user’s location data. What have been your experiences using or not using these apps?

Prompts: Why or why not are you using public transportation apps?
Prompts: What do you like or dislike about transportation apps?

[app users only]

Prompts: Why did you start using them? (If you can remember)
Prompts: Can you tell us how you use transit apps in your daily life?
Prompts: What kind of features do you use?

[Discussion]

Moderator: Next, we want to talk about how transportation apps work. How do you think these apps work? What kinds of data do you think these apps collect about you?

Prompts: Who do you think has access to data from these apps?
Prompts: What do you think they do with your data?
Prompts: What should happen with your data when using these apps?

[Discussion]

Moderator: We're also interested in knowing your concerns about mobile apps and data collection. First, do you have any general concerns about data being collected through mobile apps? Have you or anyone you know ever had an incident where your personal data was compromised or stolen, like with identity theft? How comfortable are you with sharing your location data with these apps?

Prompt: Do you ever go on your phone and look at the privacy settings? Have you made changes/what led to making those changes?
Follow-up: Some apps store your data forever, while others might delete it after some amount of time. Do you have any concerns about having your location data stored in these apps? [Ask them to elaborate or provide specific examples of what concerns them.]
Follow-up: Some apps might grant access to city agencies. For example, Baltimore's Transportation Department might want access to data from local transit apps to learn more about residents' travel in the city. How comfortable are you with sharing your data with city authorities? Are there some agencies you'd be more/less comfortable sharing this data with?

[Discussion]

Moderator: Finally, we're also interested in how you think mobile transit apps could improve public transportation. What are your thoughts?

Prompts: earlier you mentioned [expectations of transit apps], did your opinion change?
Follow-up: Knowing that transit apps collect data about your location, are there features you'd like to see that help you see what data they're collecting?

[Discussion]

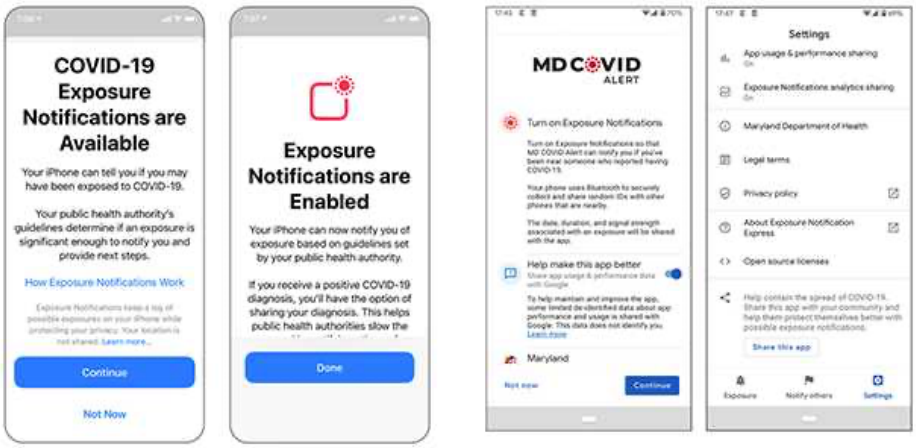
Moderator: Is there anything else you wanted to talk about today that we didn't ask?

[Time for comments]

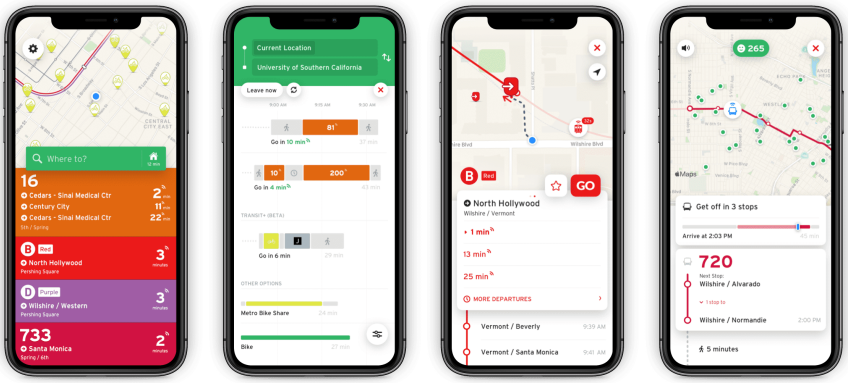
Moderator: Thank you again for your valuable time today. We appreciate your contributions and will be happy to share results from this project with anyone who is interested.

[hand out gift cards and have each participant sign receipt form]

Examples of Smartphone Applications and Smart City Sensors



Covid-19 contact tracing apps: In many states, including Maryland, the government has created a contact tracing app to help stop the spread of COVID-19. These apps work by using Bluetooth on your phone. If someone reports they have been diagnosed with COVID, the app can check where that person has been over the last two weeks, then send a push notification to other phones that were near the person who was infected.

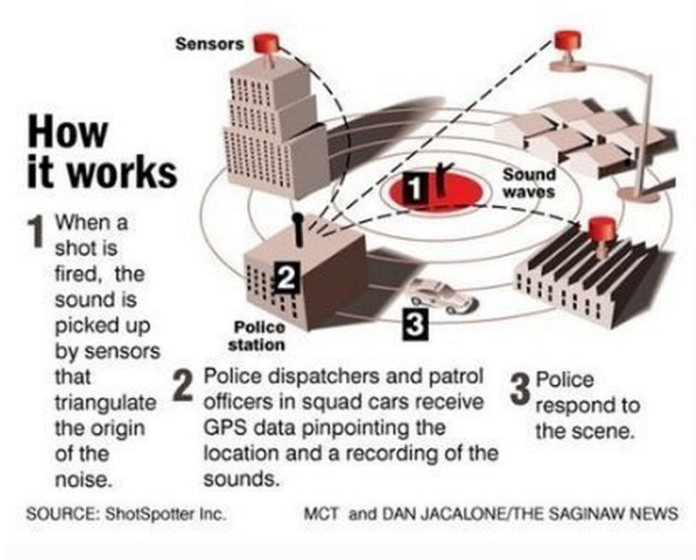


Public Transportation Apps use your location data to provide real-time transit information. Users can search destinations and the app suggests available routes.

Citizen App provides real-time notifications about crime and emergency situations in your local community. The app shares police scanner report data and residents can share video footage through the app.

Examples of Smartphone Applications and Smart City Sensors

Smart Trash Cans: Starting in 2018, Baltimore began replacing some of the public trash cans with “smart” trash cans. These trash cans look a lot like normal trash cans but also have a solar panel on top. They compact trash when they get full to save room, and they alert the city when they need to be emptied. The goal of these smart trash cans is to improve the efficiency of waste management in Baltimore.



Gunshot detector: Cities and law enforcement can use gunshot detectors to identify where in the city shots are fired. They do this by placing sensors with microphones around the city, then when a shot is detected from more than one sensor, law enforcement can be notified. The more sensors that pick up the sound, the better they can pinpoint the exact location of the gunshots. The goal of these gunshot detectors is to quickly respond to violent crimes.

Array of Things: Cities are increasingly mounting sensors on buildings and street lights around the city to collect data about the environment, infrastructure, and citizen’s activity to manage city issues such as climate, air quality, and noise. The sensors measure various data such as temperature, light, sound, and traffic. The real-time, location-based data that it collects is often available to the public.